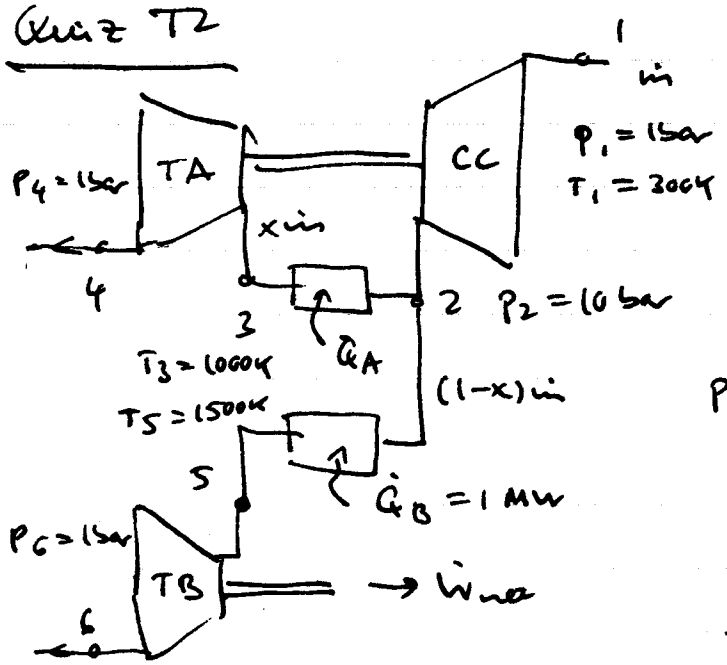
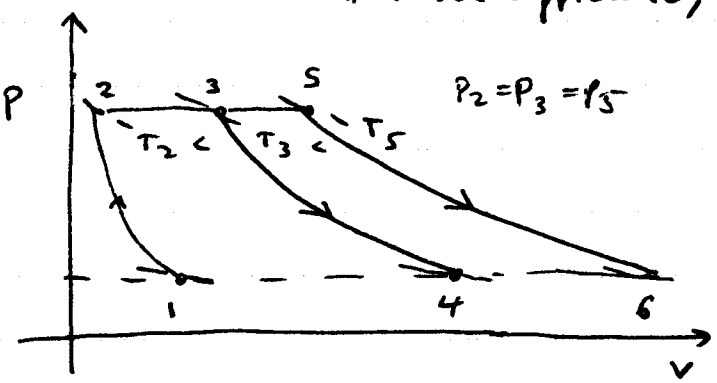
Quiz T2

16.11

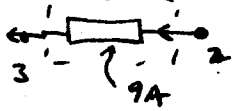
Concepts: - power cycles
- 1st law
- ad. rev. processes
- thermal efficiency





a) see on right, assume $\Delta KE = \Delta PE = 0$, ideal gas

b) ad rev. compr: $T_2 = T_1 \left(p_2/p_1\right)^{\frac{k-1}{k}}$; $\underline{T_2 = 579\,K}$

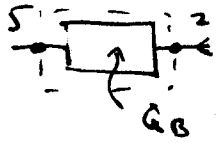
c)  $0 = q_A + h_2 - h_3$, $q_A = c_p (T_3 - T_2)$ $\underline{q_A = 423\,kJ/kg}$

d) ad rev. exp: $T_4 = T_3 \left(p_4/p_3\right)^{\frac{k-1}{k}}$, $p_3 = p_2$, $p_4 = p_1$; $\underline{T_4 = 518\,K}$

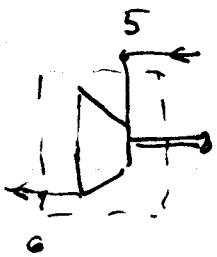
e) shaft power balance: $x\, c_p (T_3 - T_4) = 1 \cdot c_p (T_2 - T_1)$

$x = \frac{T_2 - T_1}{T_3 - T_4}$, $\underline{x = 0.579}$ $\left[\dot{m} x (h_3 - h_4) = \dot{m} (h_2 - h_1)\right]$

f) ad. rev. exp.: $T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{k-1}{k}}$, $p_6 = p_1$, $p_5 = p_2$; $\underline{T_6 = 777\,K}$

g)  $0 = \dot{Q}_B + \dot{m}(1-x)(h_2 - h_5)$

$\dot{m} = \dot{Q}_B / \left((1-x)\cdot(h_5 - h_2)\right)$ $\underline{\dot{m} = 2.57\,kg/s}$

h)  $0 = -\dot{W}_{net} + (1-x)\dot{m}(h_5 - h_6)$

$\dot{W}_{net} = \dot{m}(1-x)(h_5 - h_6)$ $\rightarrow$ $\underline{\dot{W}_{net} = 0.78\,MW}$

i) $\eta_{th} = \frac{\dot{W}_{net}}{\dot{Q}_A + \dot{Q}_B} = \frac{\dot{W}_{net}}{x\dot{m} q_A + \dot{Q}_B}$ $\rightarrow$ $\underline{\eta_{th} = 0.48}$

(note: o.k. to use $\eta_{th} = 1 - \frac{T_1}{T_2}$ since two combustors and two turbines can be viewed as one big combustor plus big turbine)